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EFFECTIVENESS OF METHYL BROMIDE/CHLOROPICRIN FUMIGATION IN REDUCING *FUSARIUM* POPULATIONS IN TWO MAJOR SOIL TYPES AT THE USDA FOREST SERVICE LUCKY PEAK FOREST NURSERY

by
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ABSTRACT

Pre- and post-fumigation soil sampling of two soil types at the USDA Forest Service Lucky Peak Forest Nursery was conducted to determine efficacy of fumigation with methyl bromide/chloropicrin in reducing populations of Fusarium *spp. Pre-fumigation* Fusarium *spp. population levels ranged from 0-10,000 propagules/g of soil. Ten days following fumigation,* Fusarium *spp. were not present at the pre-fumigation sampling sites, indicating the treatment to be highly efficacious. Populations of beneficial competitive soil fungi were moderately affected by the treatment.*

INTRODUCTION

Periodic soil fumigation with methyl bromide-based fumigants is a common practice in forest tree nurseries (1, 2, 3, 5, 7, 8). The USDA Forest Service, Intermountain Region's Lucky Peak Forest Nursery, as a standard practice, fumigates at 3-year intervals with methyl bromide/chloropicrin. One objective of fumigation is to reduce to tolerable levels pest populations including soil-borne plant pathogenic fungi which are frequently associated with seedling mortality.

Due to the occurrence of localized seedling mortality from which laboratory isolations frequently yield suspected pathogenic *Fusarium* spp., Nursery Supervisor Dick Thatcher requested that I evaluate the efficacy of fumigation in reducing populations of suspected soil-borne plant pathogens. To

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determine efficacy, I conducted pre- and post-fumigation surveys to measure changes in population levels of *Fusarium* spp. and common saprophytic fungi in two cultivated fields fumigated in 1982.

MATERIALS AND METHODS

Site History

Of the 14 fields at the nursery, only fields 4 and 5, with soils in each being predominantly composed of sandy loam and loam, respectively, were fumigated in September 1982. Recent field history includes 1979 fall fumigation with 67 percent methyl bromide - 33 percent chloropicrin at 392.3 kg/ha (350 lb/acre) followed with a 2-year crop of ponderosa pine and Douglas-fir in field 4 and lodgepole pine and ponderosa pine in field 5. Austrian peas were then grown as a green manure crop prior to cross-rip cultivation and the 1982 fumigation.

Soil Sampling

Ten sample points were selected in each of the two fields as shown in figure 1. The field 4 sample points were established at either 23, 30, or 66 m distances from the road bordering the field to the north. Field 5 sample points were selected differently due to three distinct areas of soil-color variation detected on color aerial photographs. The 10 sample points in field 5 were proportionally distributed among the three areas to accomodate the possible fungal population variances therein.

At each sample point, soil samples were collected immediately prior to and 10 days following fumigation. The following collection and processing procedures apply to both the pre- and post-fumigation soil sampling at each point.

Soil samples consisted of five soil cores extracted with a standard 2.54 cm diameter soil probe from the uppermost 15.25 cm of the soil profile. One core was taken at plot center and the others, in each cardinal direction at 30.5 cm radii from plot center. The five cores were combined in an appropriately labeled plastic bag and transported to the laboratory for evaluations.

In the laboratory, each soil sample was thoroughly mixed and a small portion placed into a petri plate. The soil in the plates was allowed to air-dry overnight by keeping the petri plate lid ajar. Serial dilutions of 1:10, 1:100, and 1:1,000 were then made using 10 g of dry soil and an appropriate quantity of sterile water. From the 1:1,000 dilution, 1 ml was transferred onto each of 5 petri plates containing 10 ml of *Fusarium*-selective pentachloronitrobenzene (PCNB) agar (4). Inoculated plates were incubated at 21° C and checked daily for presence of *Fusarium* spp.

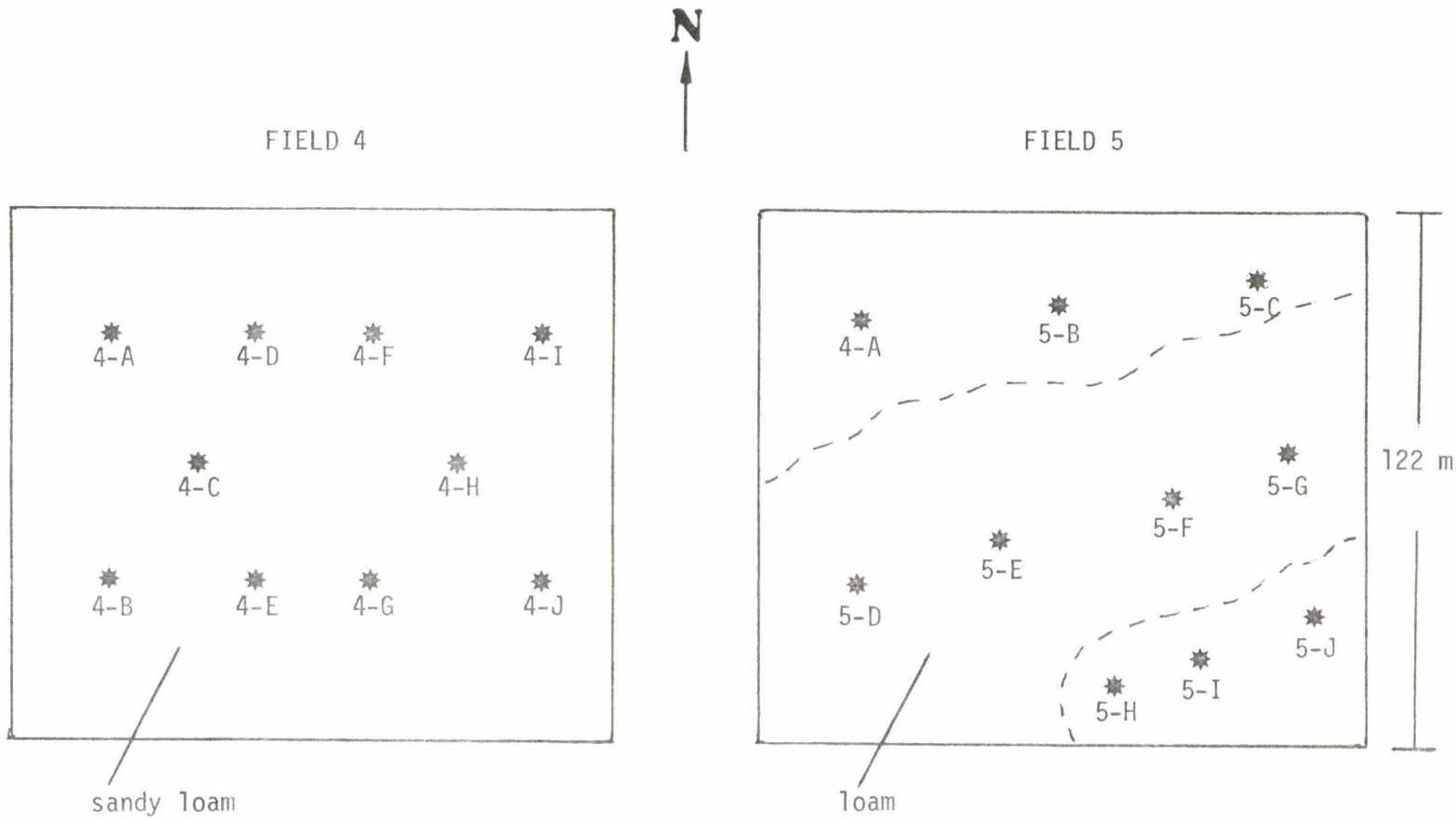

FIGURE 1. Plot layout and soil types assayed in fields 4 and 5, Lucky Peak Nursery. Dashed lines in field 5 represent delineations between distinct soil color variations as viewed on aerial photographs.

RESULTS

Pre-fumigation

Two species of *Fusarium*, *Fusarium roseum* Lk. ex Fr. emend. Snyd. and Hans. and *Fusarium oxysporum* Schlect. emend. Snyd. and Hans., often associated with seedling mortality, were isolated (table 1). *Fusarium roseum* was obtained from 6 sample points in field 4, and 2 sample points in field 5. Average number of *F. roseum* propagules per infested plot was 4,000 and 3,000 propagules per gram (ppg) dry soil in fields 4 and 5, respectively.

Fusarium oxysporum was obtained from 2 sample points in field 4, and 1 sample point in field 5. Population levels averaged 4,000 ppg dry soil per infested plot in both fields. In all three cases, *F. oxysporum* was found at sample points also yielding *F. roseum*.

Correlations between soil color variations and *Fusarium* spp. propagules in field 5 were not apparent.

Population estimates for several other groups of fungi were also made (table 2). *Trichoderma* spp. were the most ubiquitous fungi cultured, with sample point levels averaging 137,800 ppg in field 4 and 114,600 ppg in field 5. Other fungi cultured were *Penicillium* spp., *Aspergillus* spp., and yeasts. All fungi had higher population estimates in field 4 than in field 5.

Post-fumigation

Fusarium spp. were not cultured from any post-fumigation sample. Populations of *Trichoderma* spp. and *Penicillium* spp., in field 4 (table 3) were higher following fumigation than before fumigation. Populations of all other groups of fungi in field 4 and all groups of fungi in field 5 were reduced.

Total populations were reduced by 13 percent in field 4 and 41 percent in field 5.

DISCUSSION AND RECOMMENDATIONS

According to a previously reported *Fusarium* root rot hazard rating system (6), population levels above 3,000 ppg are high hazard, i.e., likely to be problem areas. In this evaluation, seven of the eight sample points yielding *Fusarium* spp. had population levels falling into the high hazard category. Even though the soil environment, as modified by various management practices, is a major factor in disease development, presence of large pathogen populations and demonstrated efficacy of fumigation support continuation of the treatment in these and similar areas of the nursery. Based on the high percentage of field 4 sample points yielding *Fusarium* spp., apparently field 4 soils are much more conducive to *Fusarium* buildup or survival than are soils in field 5. These types of soils should be closely monitored for *Fusarium* levels and appropriate management implemented.

TABLE 1. Pre-fumigation levels of *Fusarium* spp. by sample point. Population levels are listed as propagules/g of dry soil.

	Fusarium spp.		
Field/Plot	*F. oxysporum*	*F. roseum*	Total
4-A	0	0	0
4-B	0	0	0
4-C	0	4,000	4,000
4-D	0	6,000	6,000
4-E	6,000	4,000	10,000
4-F	0	2,000	2,000
4-G	0	0	0
4-H	2,000	2,000	4,000
4-I	0	0	0
4-J	0	6,000	6,000
5-A	0	4,000	4,000
5-B	0	0	0
5-C	0	0	0
5-D	0	0	0
5-E	0	0	0
5-F	0	0	0
5-G	0	0	0
5-H	0	0	0
5-I	0	0	0
5-J	4,000	2,000	6,000

TABLE 2. Pre-fumigation: average populations (propagules/g) of fungi isolated from 10 sample points in field 4 and field 5

Fungi	Field 4:	Field 5:
Fusarium spp.	3,200	1,000
Trichoderma spp.	137,800	114,600
Penicillium spp.	15,400	4,000
Aspergillus spp.	600	0
Yeasts	2,000	0
Unknown	89,200	52,600
Totals	248,200	172,200

TABLE 3. Post-fumigation: average populations (propagules/g) of fungi isolated from 10 sample points in field 4 and field 5

Fungi	Field 4:	Field 5:
Fusarium spp.	0	0
Trichoderma spp.	186,750	99,722
Penicillium spp.	26,500	278
Aspergillus spp.	0	0
Yeasts	0	0
Unknown	3,500	1,389
Totals	216,750	101,389

Results of this survey show that fumigation with methyl bromide/chloropicrin at rates indicated is effective, at least in the short term, in significantly reducing populations of *Fusarium* spp. Further, competitive fungi, which may serve to block or antagonize the buildup of *Fusarium* spp. (9), do not appear to be seriously impacted. In effect, two types of controls are being attained with fumigation: (1) short-term, direct control via toxic effects on the target organisms, and (2) long-term, indirect control via buildup of competitive organisms.

The observed differential effects of fumigation on the fungal groups sampled suggest that chemical application rate is appropriately calibrated and/or that proper application methods have been used. Such treatment should be highly efficaceous if applied to fields with soils similar to those evaluated in this study.

LITERATURE CITED

1. Cordell, C. E. 1979. Integrated control procedures for nursery pest management. In Northeastern Area Nurserymen's Conference, Bloomington, Indiana. pp. 43-51.

2. Fuller, L. R., et al. 1980. Reduction of pathogenic soil fungi at Mt. Sopris Tree Nursery and Big Sioux Conifer Nursery using Dowfume MC-33. Forest Insect and Disease Mgt. Region 2, Biological Eval. R2-80-1. 13 pp.

3. Johnson, D. W. 1973. Evaluation of soil fumigation and sulfur amendment treatments on populations of *Pythium* and *Fusarium* spp. and ponderosa pine survival in the Bend Pine Nursery. USDA For. Serv., Insect and Disease Control, Region 6, Progress Rpt. 14 pp.

4. Johnson, L. F., and E. A. Curl. 1972. Methods for research on the ecology of soil-borne plant pathogens. Burgess Publishing Co. 247 pp.

5. Lock, W. 1973. *Fusarium* root rot of Douglas-fir nursery seedlings. Forest Insect and Disease Survey, Pest Leafl. No. 61. 7 pp.

6. Robbins, K., and L. A. LaMadeleine. 1979. Soil-borne pathogen survey of two nurseries in Michigan. Forest Insect and Disease Management, Northeastern Area, Detection Rpt. NA-FB/U-3. 4 pp.

7. Smith, R. S., Jr. 1975. *Fusarium* root disease. In Forest Nursery Diseases in the United States. Agric. Handbook No. 470, pp. 9-10.

8. Sutherland, J. R., and R. L. Anderson. 1980. Seedling disease and insect problems related to nursery soil conditions in North America. In Proceedings: North American Forest Tree Nursery Soils Workshop, Syracuse, NY. pp. 182-190.

9. Wood, R. K. S., and M. Tveit. 1955. Control of plant diseases by use of antagonistic organisms. Bot. Rev. 21:441-492.

PESTICIDE USE STATEMENT

Pesticides used improperly can be injurious to man, animals, and plants. Follow the directions and heed all precautions on the labels.

Store pesticides in original containers under lock and key--out of the reach of children and animals--and away from food and feed.

Apply pesticides so that they do not endanger humans, livestock, crops, beneficial insects, fish, and wildlife. Do not apply pesticides when there is danger of drift, when honey bees or other pollinating insects are visiting plants, or in ways that may contaminate water or leave illegal residues.

Avoid prolonged inhalation of pesticide sprays or dusts; wear protective clothing and equipment if specified on the container.

If your hands become contaminated with a pesticide, do not eat or drink until you have washed. In case a pesticide is swallowed or gets in the eyes, follow the first aid treatment given on the label, and get prompt medical attention. If a pesticide is spilled on your skin or clothing, remove clothing immediately and wash skin thoroughly.

Do not clean spray equipment or dump excess spray material near ponds, streams, or wells. Because it is difficult to remove all traces of herbicides from equipment, do not use the same equipment for insecticides or fungicides that you use for herbicides.

Dispose of empty pesticide containers promptly. Have them buried at a sanitary land-fill dump, or crush and bury them in a level, isolated place.

NOTE: Some States have restrictions on the use of certain pesticides. Check your State and local regulations. Also, because registrations of pesticides are under constant review by the U. S. Department of Agriculture, consult your county agricultural agent or State Extension specialist to be sure the intended use is still registered.